# Automated Hydroponics System

## Divide and Conquer V2


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# Automated Hydroponics System

## 1.0 Project Narrative

### 1.1 Project Motivation

Hydroponics is a big field in the farming industry. Hydroponics allows farming companies to more efficiently produce their crops. Some benefits of hydroponics in comparison to traditional farming methods are more efficient usage of water, increased crop production, and faster plant growth. Most of these benefits allow companies to increase production, create a better product, and increase their profits. Unfortunately, hydroponics is not an easy thing for the average everyday person to implement into their own plant growing methods. There are some commercial options, but many are expensive and require the user to run the system mostly manually. This motivation for this project is to make a hydroponics system that uses automation in order to make it more accessible to the average user at home. According to figure 5 and 6, we should be able to finish this project in a timely fashion and have some room for testing with plants.

### 1.2 Goals and Objectives

For this project we wish to create an automated hydroponics system that makes this farming method more accessible to the consumer. One goal is to keep the system manageable with a relatively compact and well built design. We also will make the system power efficient and we will attempt to implement hydroelectric power in order to conserve energy. There will be a multitude of sensors in order to monitor the system environment and more easily monitor the plants. There will be methods to reduce maintenance and minimize manual interaction of the user. Overall this will be a system that will require minimal human input and will allow users to more efficiently grow plants. We wish to keep the project cost within a relatively reasonable budget of 1000 dollars. The budget is outlined more specifically in Table 1 near the end of this documentation. While we are trying to keep this project within a reasonable price range, there are multiple factors to consider that are shown in figure 2 that will have an impact on the user's experience. Therefore, we are going to optimize these factors for the consumer.

### 1.3 Project Function

The hydroponic system will work off of a standard home power outlet and have an internal battery allowing for short term operation in case of power loss or disconnect. We will monitor the PH of the water using sensors and handle the readings accordingly. We will also monitor the CO2 levels in order to make sure they are within viable levels for the plants. There will be various other sensors such as lighting sensors which keep track of the light levels the plants are receiving. Water pumps will be used to move the water throughout the system and feed water to the plants. There will be a way to flush the water out of the system for easy maintenance. The lighting will be able to be controlled and be changed to the plants needs along with being set on a timer for day/night cycle simulation. The user will be able to add nutrients to the system through the systems automation in order to balance out the health of the plants. All

of this will be controlled and monitored using a microcontroller and some sort of user interface. The most likely interface being that of an android app. This will allow the user to easily use the system with their phone. The user will be able to monitor the current state of the vitals through feedback from the sensors. While also being able to set custom profiles for specific plant setups allowing for changing the system to grow different types of plants with ease. That said, our prototype hydroponics system will roughly resemble the base structure as figure 1 in terms of water flow, pump design and growth trays. There are other components that will be added on that were mentioned before, like a light source, microcontroller and proper structure, that will add to the system. Thus, making this hydroponic system easier to use and requires less intervention from the consumer.

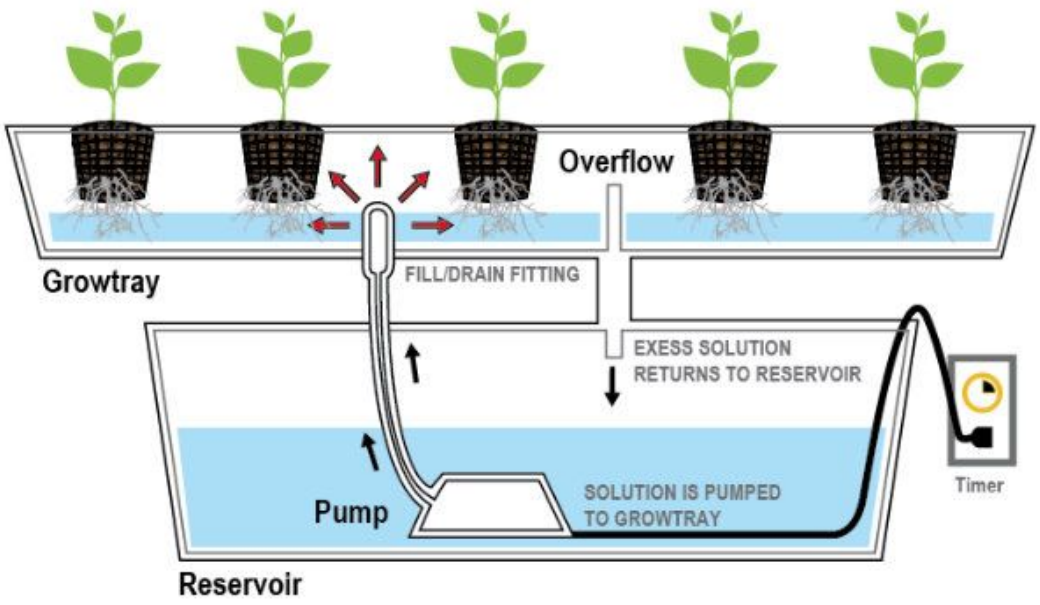



*Figure 1 - Example System of Home Hydroponics*

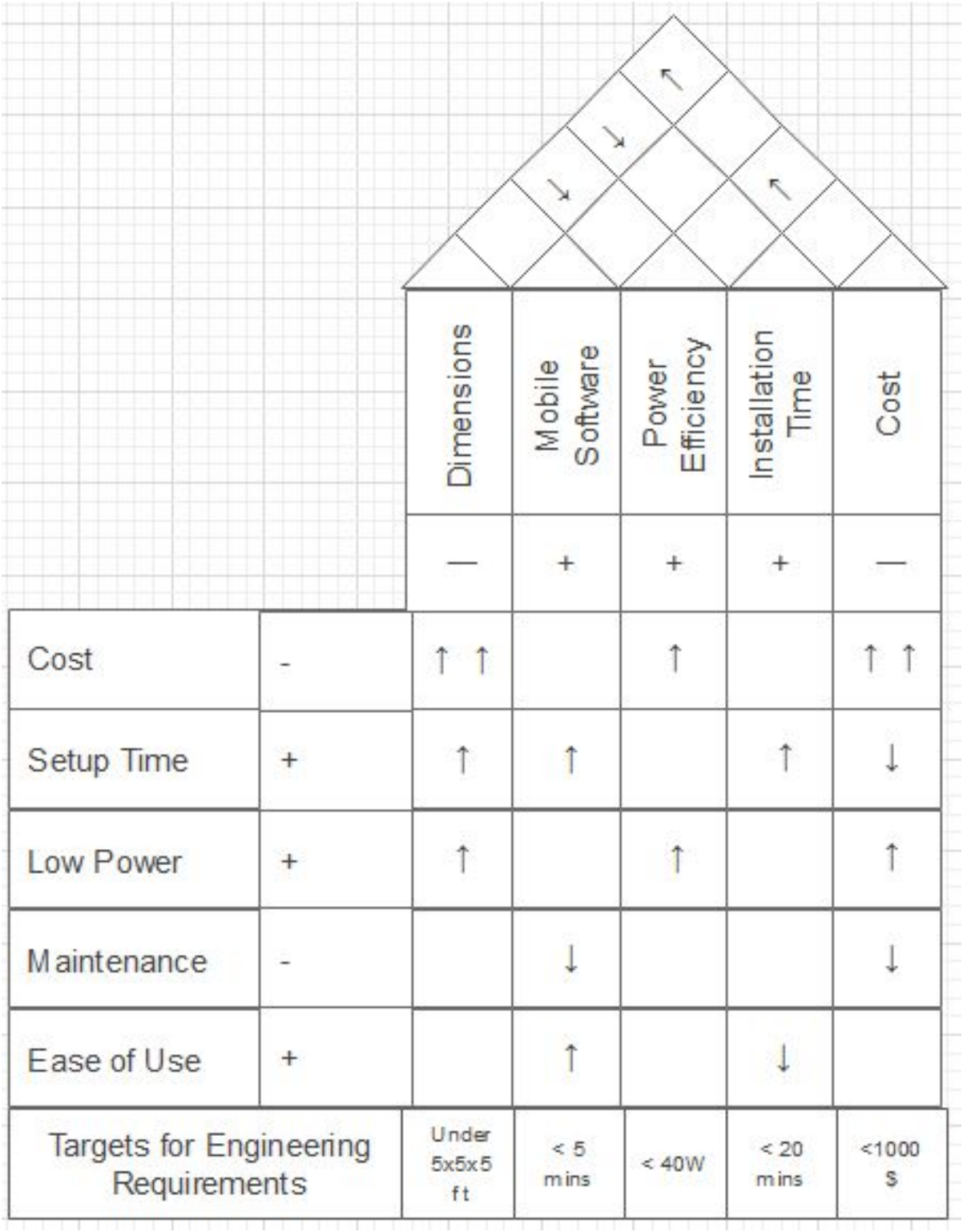
## 2.0 Requirement Specifications

1. Power/Energy
    - Sustainable Battery: That can run the microcontroller and any other components needed to keep the system self sustainable for a decent amount of time in case a dedicated power connection is unavailable.
    - Hydropower Implementation: use the flow of the water in the pumps to generate power to be stored in a battery. This could be used to power other electronics in the system to save energy or charge external devices like cell phones.
    - Hard wall connection to a standard power outlet for consistent and reliable power. This will be the main source of energy and the recommended use case.
2. Microcontroller
    - We will need a microcontroller in order to manage and control important data.
    - Will need to connect to various sensors.
    - Connect to water pumps and lighting.
    - Be power efficient and easy to work with.

- Flexible design that gives us room to easily add and remove features as we go.
- Connect to the internet with Wifi module for Android and database information.

3. Sensors
    - CO2 Sensor.
    - PH Sensor.
    - Temperature Sensors
    - Sensors to measure light/brightness levels.
    - Potential other sensors for plant and water quality.
    - Sensors to measure distance between lighting and the plants to control lighting height.
4. Hardware
    - Various Pumps for water flow and to administer ph liquids.
    - Lighting Equipment.
    - Various plumbing for water flow and connections.
    - Water Reservoir(s).
    - Construction to hold the plants.
    - Materials for the physical construction of the overall project.
    - Plumbing to empty water from the system easily.
    - Nutrient Adder. We want to be able to add nutrients to the water in the system in order to provide plants with their requirements.
    - Filters to clean out outgoing water.
    - Water turbines with additional energy. (if possible)
    - Lift/pulley for lighting: We are considering adding lifts to the lighting such that the lights raise with the height of the plants so that lighting levels remain constant and predictable.
5. Software
    - Software for the microcontroller.
    - Reference Figure 4 below for basic design outline.
    - Keep basic and focus on functionality.
    - Have a way for the user to interact with the system.
        - ❖ Use LEDs
        - ❖ Buttons
        - ❖ Display
        - ❖ Switches
        - ❖ Phone
    - Android App
        - ❖ Allow the user to monitor system vitals.
        - ❖ Provide Plant upkeep information.
        - ❖ Provide easy interaction with the system.
        - ❖ Support many versions of android.
        - ❖ Connect over the internet with our microcontroller.
        - ❖ Use database to store the data.
        - ❖ Potential implementations would be using android studio or other mobile development frameworks. Databases will use SQL or NoSQL methods.
6. Project Constraints
    - Cost: Important to keep the project in a reasonable budget.
    - Power and Energy Efficiency.
    - Time to work on the project.
    - Form factor.

### 3.0 House of Quality



| | | Dimensions | Mobile Software | Power Efficiency | Installation Time | Cost |
|---|---|---|---|---|---|---|
| | | — | + | + | + | — |
| Cost | - | ↑ ↑ | | ↑ | | ↑ ↑ |
| Setup Time | + | ↑ | ↑ | | ↑ | ↓ |
| Low Power | + | ↑ | | ↑ | | ↑ |
| Maintenance | - | | ↓ | | | ↓ |
| Ease of Use | + | | ↑ | | ↓ | |
| Targets for Engineering Requirements | | Under 5x5x5 ft | < 5 mins | < 40W | < 20 mins | <1000 $ |

*Figure 2 - House of Quality*

## 4.0 Block Diagrams

Hardware Diagram

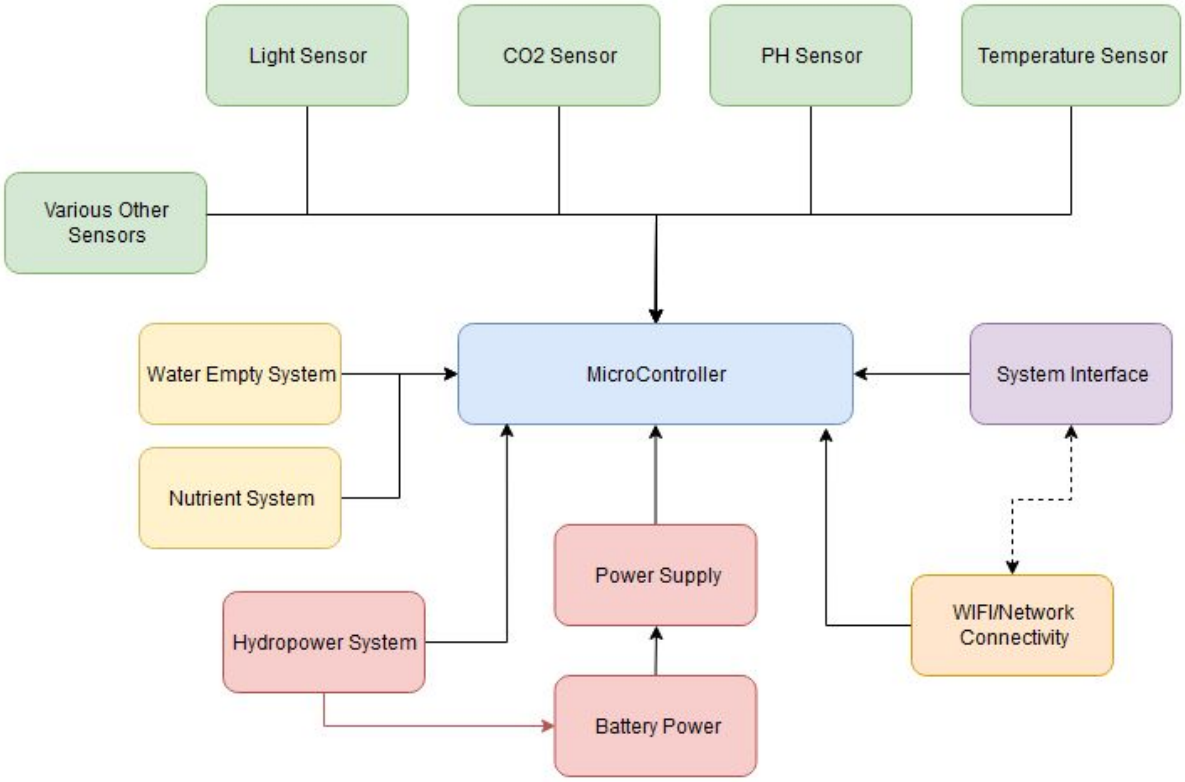



*Figure 3 - Hardware System Block Diagram*

Software Diagram

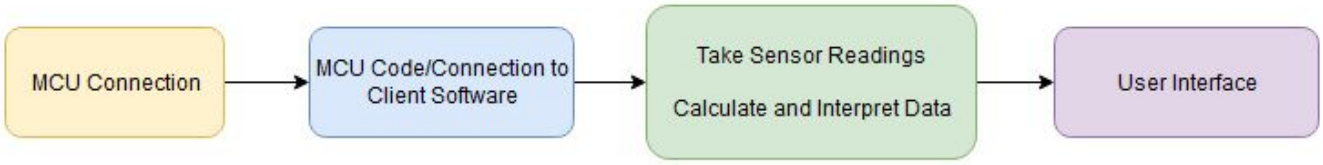



*Figure 4 - Software Block Diagram*

Member Responsibilities

The CpE Majors will have more focus on Software and MCU related subjects while ECE majors will focus more on the power and electrical system. Together we will work to integrate both the electrical and computer sides of the project along with any mechanical and construction based needs.

## 5.0 Estimated Project Budget and Financing

| Item/Part | Estimated Cost |
|---|---|
| Microcontroller | $100-125 |
| Battery | $200 |
| Various Sensors | $100-$250 |
| Various Plumbing | $50-$100 |
| Water Tanks | $25 |
| Water Pumps | $25-$50 |
| Lighting | $50-$100 |
| Other Electronics | $50-150 |
| Various Construction Materials | $50-100 |
| Misc. Supplies | $50 |
| Total Cost | $700-$1150 |

*Table 1 - Project Cost/Budget*

## 6.0 Project Milestones

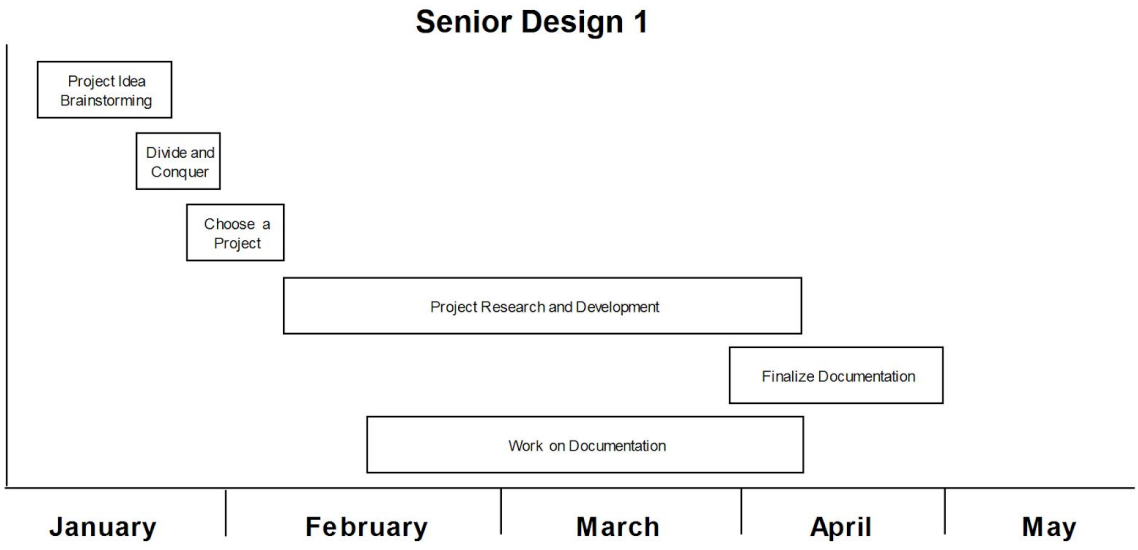



*Figure 5 - Senior Design 1: Shows outline of planned work to complete during the SD1 Semester*

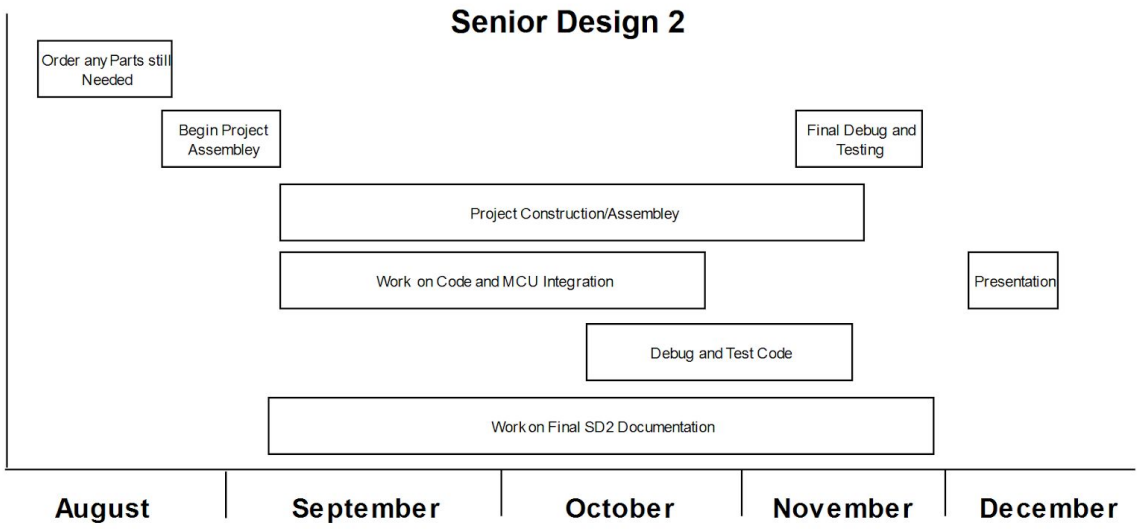



*Figure 6 - Senior Design 2: Shows outline of planned work to complete during the SD2 Semester*